Technology Trends
Communications

Center for Learning in Retirement

CLR Fall 2020

Glen Maxson & Alan Freedman

Week 9

The What

- ~~Artificial Intelligence & Machine Learning~~
- ~~Robots & Drones~~
- ~~Autonomous Transportation Systems~~
- ~~Surveillance~~
- ~~(Cyber) Crime, Security & Warfare~~
- ~~Medical Tech~~
- ~~Media~~
- ~~(Virtual) Money & Blockchain~~
- Communication
- Space
- Earth & Sky

1870 plus the next 6 decades…

- By 1929, urban America was electrified and almost every urban dwelling was networked, connected to the outside world with electricity, natural gas, telephone, clean running water, and sewers.
- By 1929, the horse had almost vanished from urban streets, and the ratio of motor vehicles to the number of households reached 90 percent.
- By 1929, the household could enjoy entertainment options that were beyond the 1870 imagination, including phonograph music, radio, and motion pictures exhibited in ornate movie palaces."

Source: Robert J. Gordon, economist, *The Rise and Fall of American Growth: the U.S. Standard of Living Since the Civil War,* 2016

And this...

- "The first modern mass medium, radio made America into a land of listeners, entertaining and educating, angering and delighting, and joining every age and class into a common culture. . . Radio created national crazes across America, taught Americans new ways to talk and think, and sold them products they never knew they needed. Radio brought them the world."

Source: Tom Lewis, historian, "'A Godlike Presence': The Impact of Radio on the 1920s and 1930s," 1992

And of course, this…

- **Television** technology was actually first developed in the 19th century, before commercial radio was conceived of, when, in 1897, Ferdinand Braun invented the cathode ray tube. The first time the cathode ray tube was used to produce images was in 1907.

- By the end of the 1920s, the United States had a total of fifteen experimental stations for mechanical television. In 1929, Herbert Hoover, at the time the Secretary of Commerce, made an appearance on the mechanical television of AT&T.

- At the close of World War II, there were less than 7,000 working television sets, and only nine stations on the air, in the entire country.

- During the first five years of the 1950s, ownership of televisions skyrocketed, affecting other forms of entertainment available to the public. This time period witnessed, for example, the closing of many movie theaters, as motion pictures competed with television for consumer attention.

10 Communication Innovations in The Last 10 Years

- Wifi.
- Voice Over Internet Protocol (VoIP)
- IP **Communication**.
- Unified **Communications**.
- Smart Phones & Mobile **Communication**.
- Bluetooth.
- Youtube.
- Social Networking Websites.
- Skype.
- Nimbuzz.

Wifi Pros and Cons ([source](#))

- Benefits of Using Wi-Fi

- **Efficiency** – Information transfer is fast and convenient. For example, businesses can send price quotes to clients from remote locations.

- **Flexibility** – End users are not restricted to one physical location when connecting to a wireless network. This enables more efficient use of space within an office setting.

- **Cost Effectiveness** – Wireless networks are relatively cheap to install in an office environment. It also enables greater options when selecting computer equipment.

- **Accessibility** – Wi-fi is quite popular in a public setting such as a coffee shop, bookstore, hotel or restaurant. Its available signal makes it easy to connect to the internet.

- What to Watch Out for When Using Wi-Fi

- **Security** – Wireless networks are considered more vulnerable to hacker attacks. This involves unauthorized access to your personal network and can lead to sensitive information being stolen. It is imperative to set up a strong password for your wireless network. In addition, encourage employees to use only HTTPS web sites and to enable SSL when using applications that connect to the internet. Wi-fi should be turned off when one is no longer using it.

- **Coverage** – Wireless coverage areas have a limited range of connectivity (often from 50-300 ft). Be aware of the range of the wireless signal you are connecting to. It is very frustrating to be dropped from the internet simply because you stepped out of the coverage area.

- **Speed** – The transmission of data is usually slower than most wired networks. This is because wired networks generally support a greater bandwidth and can withstand greater amounts of network activity.

Does WiFi Affect the Brain? ([source](#))

Is WiFi dangerous for the human body?

- There are many scientific studies demonstrating the detrimental effects of WiFi on the human body. It causes oxidative stress by increasing the production of free radicals.

- Increased oxidative stress is responsible for oxidative damages to cellular macromolecules, such as proteins, lipids, and DNA.

Ready for VoIP? Advantages and Disadvantages ([source](#))

- Pros
  - Lower costs
  - Increased accessibility
  - Complete portability
  - Higher scalability
  - Advanced features for small and large teams
  - Clearer voice quality
  - Supports multitasking
  - More flexibility with softphones
- Cons
  - Reliable Internet Connection Required
  - Latency and Jitter
  - No location tracking for emergency calls

IP Communication ([source](#))

- IP Communication describes networks that use Internet Protocol for voice and video traffic. IP communication can be on any network – local or global. Sometimes called Internet Telephony or Internet Communications, IP communications has come to encompass a large number of services such as telephony, video conferencing, and unified communications.

- In the near future, IP addresses will be available to nearly all devices at home and office. Not too far away, you can send instructions to your fridge to complete a particular task before you come home.

IP Telephony: The End of the World as We Know It? (source)

- *IP telephony* = voice systems that are computer-based and use the Internet protocol to ride on data networks.

- Pros
  - Fewer moving parts
  - Calls over the Internet are free
  - PBX is dead (and my investment in the technology is worth nothing)

- Cons
  - Latency
  - Reliability

Table 1

Process	Time Required in Milliseconds
G.729 compression	25
Buffer	40
PC-caused (I/O, IP stack, OS)	400
Inherent Internet latency	300
TOTAL	765

This table is based on an article by David Passmore, "Delayed Voice over IP," Business Communications Review, December 1997, 18-20.

Table 2

Availability		Annual Downtime	
		Minutes	Days
Voice standard	99.999%	5.5	—
Private data networks	94%	31,536	22
Carrier data networks	91%	47,304	33
Public Internet	61%	204,984	142

This table is based on information in an article by Mary Thyfault, "Voice-Data Integration," Information Week, April 13, 1998. [http://www.techweb.com/se/directlink.cgi?IWK19980413S0039]

The Pros and Cons of Smartphones ([source](#))

- In business - [The Pros and Cons of Smartphones](#)
  - Cons - Text miscommunication, security risks, productivity concerns
- For children – [Pros and Cons of Cell Phones Becoming a Major Part of Children's Lives](#)
  - Pros - Access to information, keep in touch
  - Cons - Cheating, distracting, sexting, undesirable access
- For the rest of us - [Smartphone Pros & Cons](#)
  - Pros - Convenience, record/share the moment, stay connected
  - Cons - Distraction, staying connected, cost, complexity

Advantages and disadvantages of Bluetooth ([source](#))

- [What is Bluetooth](#)?
  - **Bluetooth** is a [wireless](#) technology standard used for exchanging data between fixed and mobile devices over short distances using [UHF](#) [radio waves](#)
- Pros
  - It avoids interference from other wireless devices.
  - It has lower [power](#) consumption.
  - It is easily upgradeable.
  - It has range better than Infrared communication.
  - The Bluetooth is used for voice and data transfer.
  - Bluetooth devices are available at very cheap cost.
  - No line of sight hence can connect through any obstacles.
  - Free to use if the device is installed with Bluetooth.
  - The technology is adopted in many products such as head set, in car system, printer, web cam, GPS system, keyboard and mouse.
- Cons
  - It can lose connection in certain conditions.
  - It has low bandwidth as compared to Wi-Fi.
  - It allows only short-range communication between devices.
  - Security is '[weak](#)' as it can be hacked.

Phone Calls, Texts Or Email? Here's How Millennials Prefer To Communicate ([source](#))

- **Aversion to Phone Calls**
  - instant messaging, texting, email, etc. are instantaneous, and provide the ability to think over your words
- **Text Messages**
  - 68% of millennials [text "a lot"](#), compared to 47% of Gen X
  - They're instant and mobile, and support mass-messaging capabilities
- **Emails**
  - Over [205 billion emails are sent every day](#)
  - emails are less urgent, and provide more space than text messages
- **Informal Communication**
  - communication is friendlier, more casual (ex. [emojis](#), are more popular)

Also

- Social Media

- Blogging

- Video Chat

- Live Web Chat (aka Video Conferencing)

- Social Virtual Reality (I Don't Think So!)

Let's Talk About the 'G's (source)
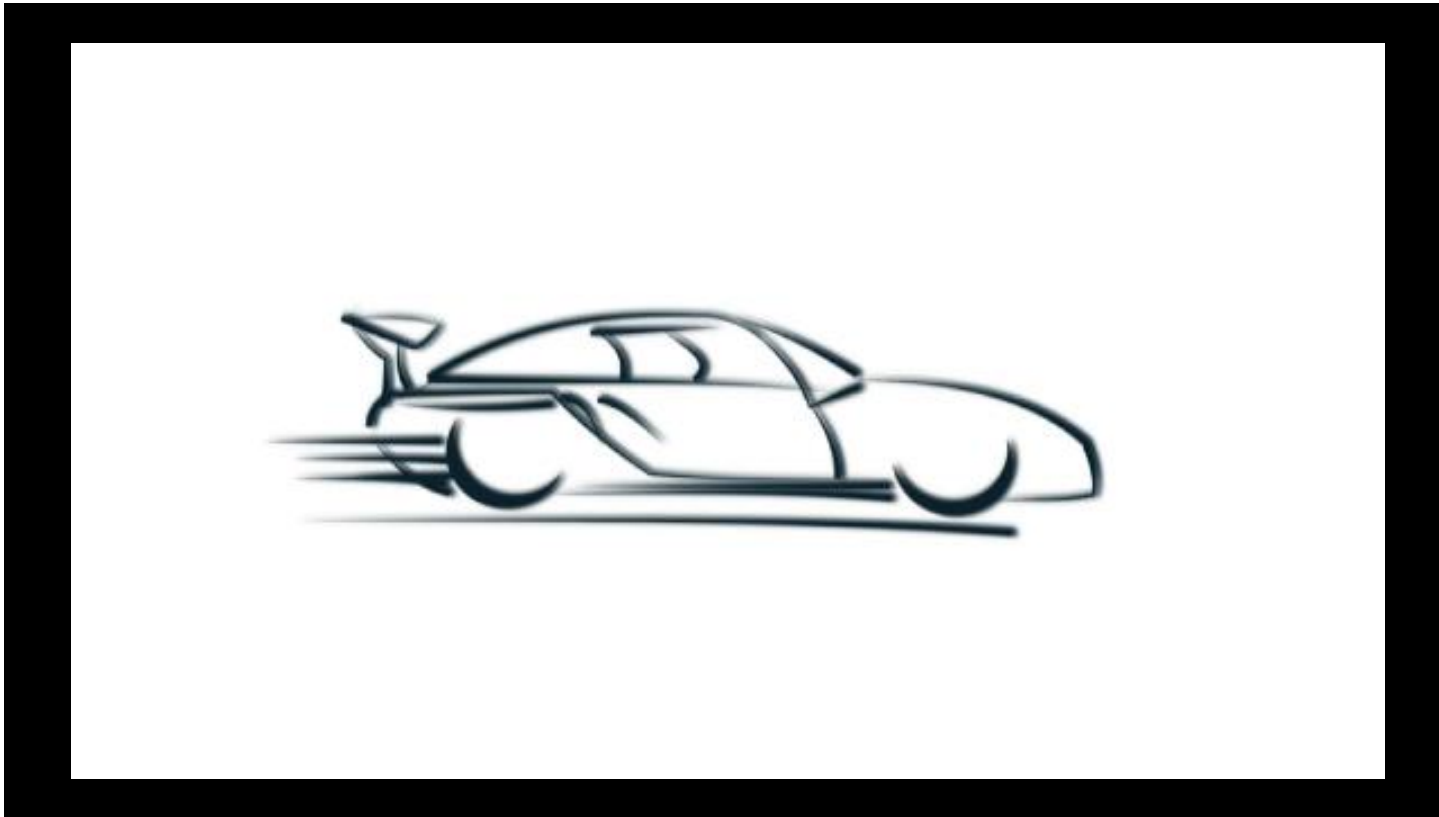
5G ([source](#))

- 3G frequency 1.8 – 2.5 GHz
- 4G frequency 2 - 8 GHz
- 5G supports frequencies up to 300 GHz
  - higher frequencies are called 'millimetre wavelengths' (1 and 10 millimetres (higher frequency doesn't mean higher intensity)
  - 5G's 26 GHz the radio wave is absorbed in the outer layers of the skin rather than getting into the brain tissue
  - But since shorter wavelengths don't penetrate like longer ones, it also means 5G phone towers need to be placed closer together
    - The area covered by the cell tower is [usually around 1 to 20 kilometres](#) wide
    - At weaker frequencies, each tower covers less area, therefore you need more towers. However, shorter waves also mean that many more devices can be connected to one phone tower at once.
    - 5G potentially offers network connection speeds that will be substantially higher than what's currently available.

What is 'Integrated Photonics'? ([source](#))
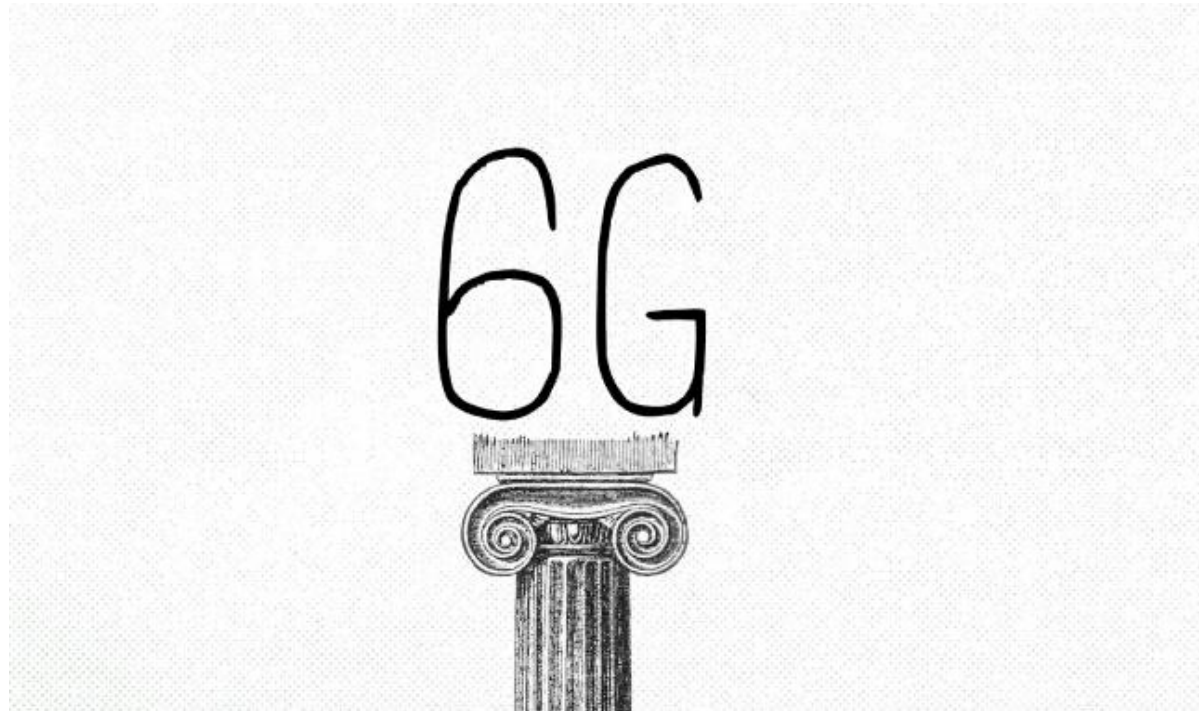
What's the problem with the 'odd' Gs?

6G will be the sixth generation of <u>wireless communications</u> technologies supporting cellular data networks. It will be the successor to <u>5G</u> and will likely be significantly faster, at speeds of ~95 Gb/s. 6G will likely become commercially available in the <u>2030s</u>.

- There is a folklore in the comms business that <mark>all of the even Gs are great and all of the odd ones are terrible</mark>.
- The theory goes that we need to move onto 6G as soon as possible to fix the inevitable issues that the cursed 5G technology.
- Academia and some industry labs are already buzzing about what 6G might be.
  - auto tuning of the modulation
  - machine learning to set chunks of the modem operation on the fly

The effects of extremely low frequency electromagnetic fields (EMFs) may cause diverse health effects ([source](#))

Dr. Pall talks about the 'Invisible Force Driving the Sickness of Technologically Advanced Societies' ([source](#))

8 pathophysiological effects caused by non-thermal microwave frequency EMF exposures ([source](#)) ([video](#))

1. **Attack our nervous systems including our brains leading to widespread neurological/neuropsychiatric effects**

2. **Attack our endocrine (that is hormonal) systems**

3. **Produce oxidative stress and free radical damage**

4. **Attack the DNA of our cells, producing single strand and double strand breaks in cellular DNA and oxidized bases in our cellular DNA**

5. **Produce elevated levels of apoptosis (programmed cell death)**

6. **Lower male and female fertility, lower sex hormones, lower libido and increased levels of spontaneous abortion and attack the DNA in sperm cells**

7. **Produce excessive intracellular calcium $[Ca2+]i$ and excessive calcium signaling.**

8. **Attack the cells of our bodies to cause cancer**

Satellite Communications (source)

More On StarLink (source)
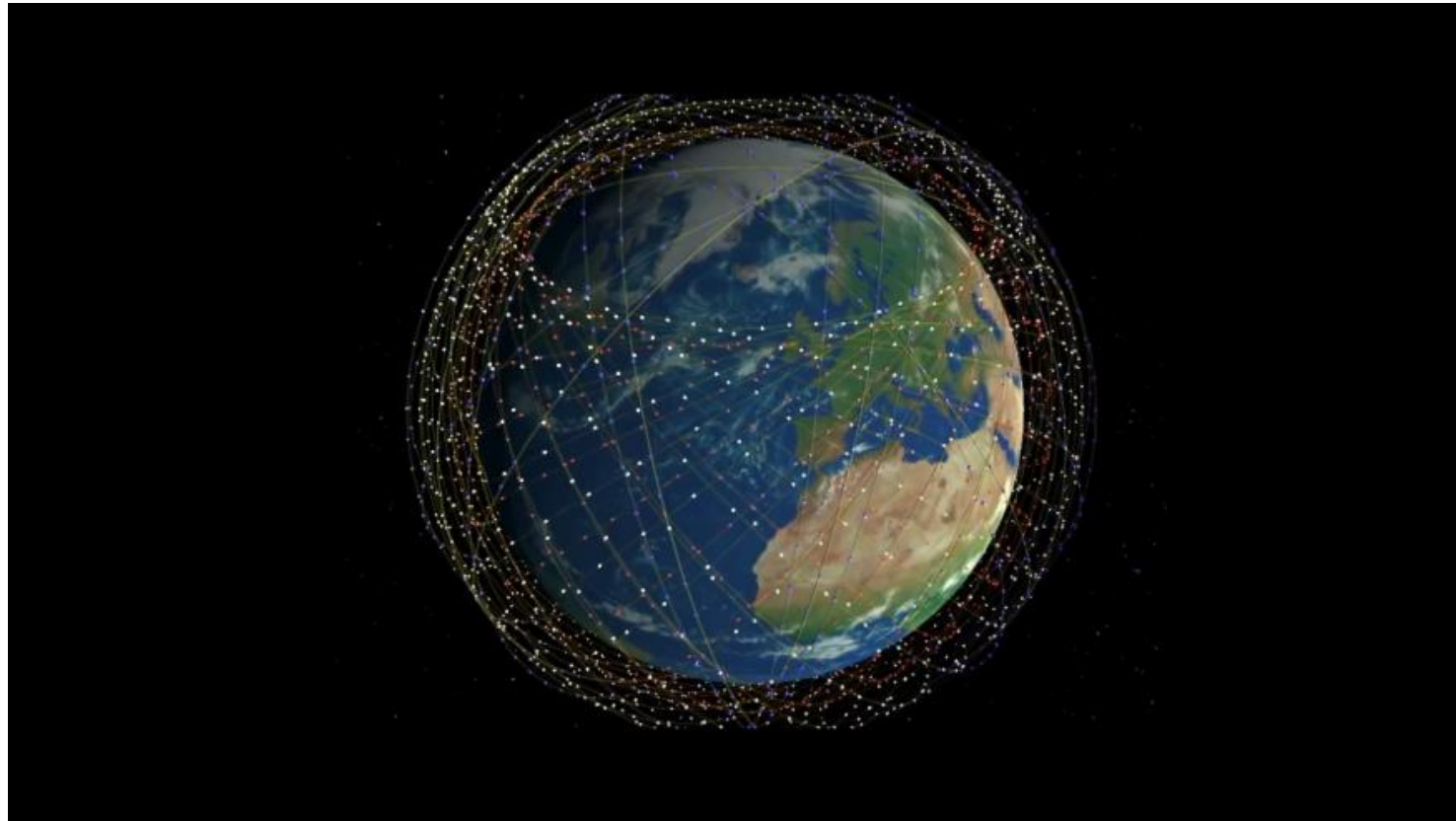
The Truth About Space Debris (source)

Technology Drives New Satellite Communications Capabilities

- **The democratization of space is underway in orbit above the Earth.**

-
    The next era of satellite communications is upon us in the form of low-earth-orbit constellations aiming to revolutionize personal connectivity, according to satellite experts. These new satellite swarms are being driven by technology innovations simultaneously with the growth of less-expensive launch services. The result will be an explosion in the number and type of orbiters serving their earthbound hosts while raising the bar for support technologies on the ground.

- See also: link

Top Information and Communication Technologies

Top 5 Emerging Trends Impacting Communications Technology

- **Proliferation of Cloud Services**

- Cloud services have been a major emerging technology for the past decade. If you've read this blog, you know we've been talking about them year after year. And yet, they *still* continue to be the main driver of change in enterprise technology stacks. Cloud has been disrupting every aspect of traditional IT business operating models, and industry analysts predict that the current cloud adoption push will continue to experience 23% CAGR (Compound Annual Growth Rate) through 2022.

- Cloud services continue to expand and differentiate, from SaaS to Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Communications Platform as a Service (CPaaS), Unified Communications as a Service (UCCaaS), Video Conferencing as a Service (VCaaS) and more. Enterprises that have adopted cloud services experience improved time to market (making them more competitive), increased efficiency and, when done correctly, realize reductions in IT spend. Cloud services also enable faster access to infrastructure, greater scalability and higher availability. Those are major improvements for any enterprise and show, that at least for now, cloud is here to stay and there is plenty more room for growth.

- **SD-WAN**

- An SD-WAN is a software-defined wide area network, an application of software-defined networking technology that simplifies WAN (Wide Area Network) management by decoupling network hardware from control mechanisms. Conventional network architectures were not built for the demands of a cloud-first workplace, and SD-WAN enables easier access to cloud applications for geographically-distributed offices and a mobile workforce. It allows enterprises to build higher-performance WANs using lower-cost commercial Internet access. SD-WANs are also quicker to establish and reconfigure, since the network becomes a logical layer, compared to all the overhead and latency of implementing a traditional hard-wired physical network.

- Gartner forecasts that SD-WAN technology will grow at a 59% compound annual growth rate through 2021 to become a $1.3 billion market. And it's no wonder why. By bringing the principles of the cloud to networks, SD-WAN brings various benefits to enterprise IT, such as faster network deployments, resilience, security, lower costs, simpler management, agility and scalability, and improved application delivery.

- **Autonomous Things**

- Topping Gartner's list of Top 10 Strategic Technology Trends to look out for in 2019 was "autonomous things," and we'd be remiss to not include it here. So what are autonomous things? "Autonomous things" is an emerging term for technologies that are bringing computers into the physical environment operating as autonomous entities without human direction. While this encompasses a broad range of technologies combining AI, drones, and other tech, Gartner breaks it up into the following categories: vehicles, drones, appliances, agents and robotics. The real value achieved by autonomous things is that they are able to capture and transmit information and seamlessly communicate it via the network to backend systems where that data can be automatically analyzed and acted upon.

- Over the coming years, almost every application, service and IoT will incorporate some form of AI automation for certain tasks and narrowly-defined purposes. One thing is certain: the development of AI in existing technologies will be a major driver of innovation and disruption in the near future. As autonomous things proliferate, experts expect the focus to shift from individual autonomous objects to swarms of collaborative devices working together, with or without human input.

- **Augmented Analytics**

- According to Gartner, augmented analytics is an approach that automates insights using machine learning and natural-language generation and marks the next wave of disruption in the data and analytics market. **They've also called it a "third wave for data and analytics capabilities" because it eliminates manual intervention by executing automated algorithms that sift through massive amounts of data to generate decisions, which can be predictive and/or prescriptive based on multi-dimensional statistical analysis.**

- Increased automation in analytics, thanks to machine learning and AI being applied to Business Intelligence (BI), is resulting in the evolution of business analytics from being descriptive to predictive and prescriptive analytics. Gartner predicts that by 2020, 40% of data analytics tasks will be automated. As platform capabilities mature, analytics managers should plan to adopt augmented analytics technologies.

- **5G**

- After years of anticipation, 5G is finally here and expected to roll out on a wider scale in 2019. 5G is the fifth generation of cellular mobile communications, following the 4G (LTE/WiMax), 3G (UMTS), and 2G (GSM) systems. 5G represents a fundamental shift in communication network architectures, promising more bandwidth with lower latency. Theoretically, 5G can be 20 times faster than 4G! It should also increase data rates, improve connection density, reduce latency and strengthen connection security all-around. However, the most important innovation of 5G is the ability to make networks ubiquitous. This will allow users to transfer between networks without experiencing service disruptions.

Ten Communications Technology Trends for 2018

1. **5G Sides Safely off the Hype Curve and Makes a Nice Boring Landing**
   We were a little premature with this one, so we will repeat it again this year. We know of some large deployments this year. In the USA Verizon is aggressively predicting roll out this year and ATT expects to get there before years end. A proper worldwide summary of all of this excitement is an article all by itself. Suffice to say, what is actually meant by 5G is complicated…

2. **Massive MIMO Implementation Proves to Be at Least as Exciting as Massive MIMO Theory**
   So now we actually want to deploy these things, and for millimeter wave deployments they are essential. But the power and cost remain non trivial issues. There has been a significant uptick in the academic literature on massive MIMO implementation. Searching IEEE explore using "massive MIMO implementation" we found 287 papers since 2005 with 128 in 2017-2018. Single bit ADC solutions seemed to dominate, surrounded by a lot of hybrid pre-coding designs and a few FPGA and even ASIC test beds. More exotic ideas are out there if you look for them. We will continue to see innovation in this space thru 2018 and 2019.

3. **Machine Learning. If You Are Not Doing It, People Will Shun You at Parties**
   This was the year in which we all decided that a little Machine Learning was good for everything. Egged on by the announcement of Google's Tensor Processing Unit (TPU), for which the first solid public description emerged in 2017 but is already at v3, suddenly we had Tensor Flow and you didn't need a CS degree to be a machine learning expert anymore. Silicon Valley's VC crowd, having gone off the long development cycles of chip design in the early 2000s, got so excited they started funding silicon implementation of AI machines. If you are building a handset SoC and you don't claim an AI accelerator you will be made to stand facing the corner with a pointy hat on at ISSCC. But we are not too sure what we will do with all of that AI processing yet. Facial recognition? Lets hope there is something more exciting on the horizon. Back in the infrastructure space there are some very serious attempts to apply ML to network optimization. There are even academic proposals to machine learn the modulation on a link by link basis, something we are calling auto tuning. We predict all of this excitement has a couple of year of runway at least.

4. **Internet of Things. Did the Borg Collective Take Over? Well Not Yet.**
   After our prediction of world domination last year IoT has slid right off the hype curve in our opinion. This despite the fact that the head of Softbank predicted that our shoes would soon by smarter than their wearers. But maybe this has allowed some solid progress to be made quietly by some serious people. Indeed the rate of addition of smart cars and smart watches far outpaced that of new smart phones. Even Amazon was surprised by the popularity of Alexa and last year was the year that ride share bikes really appeared on the streets of large cities. We predict that other unexpected applications will pop up in 2018 and 2019 and the great killer app of IoT is still in our future. Progress has been slowed by what the Economist called the "techlash" against sharing of personal data and the use of drones. A couple of self driving car crashes took the sheen of that technology in the eyes of the public. Significantly, CES didn't really show any strong new themes, with focus on things like better cellphones, slightly smarter watches, and really big TVs. So much for our prediction of the smart hairbrush…

5. **Driverless Cars, Coasting Down the Hype Curve**
   OK, so in 2018 we are not all going to work in driverless cars after all. With some of the dazzle taken off Uber and Tesla, as they struggle for various business reasons to make a good profit, we will look more to the traditional car manufacturers to introduce driving enhancement features. But the completion of 5G has given us a framework for V2X (vehicle to everything) communications which will add to our driving experiences once 5G is deployed. DSRC continues to make progress. But even the most basic of driverless applications, truck platooning, has failed to make it to the road yet. So we will back off our frothy predictions and say that solid progress will be made through 2019 in conjunction with 5G deployment.

6. **Security, Privacy and a New Round of Elections**
   One year into the election meddling scandal, conspiracy, or whatever you may think it is, many people continue to worry about access to private data. As we predicted last year, this may have had a significant impact on enthusiasm about IoT. However it turns out that the biggest security threat isn't having your information stolen but rather that you gave it away. But we predict that security issues will be a drag factor on IoT technology take up in 2018 and 2019.

7. **Distributed Ledgers, the End of Banks and the Beginning of a New Way to Run Networks**
   More generally we would like to take some credit for getting this prediction a little right. In the last year there has been a lot of activity in redefining the network as softer, disaggregated and rapidly flexible to new services. All of this aligns with the completion of the 5G standard and we are optimistic that the operators now have the tools in place to rapidly take advantage of new business opportunities using a much more flexible network architecture than we have seen in the past. We predict that the potential and value of this quiet revolution in network architecture will have a large impact on the rate of wireless evolution in the next year or two. But OK, the banks don't look like they are going anywhere…

8. **6G**
   There is a folklore in the comms business that all of the even Gs are great and all of the odd ones are terrible. The theory goes that therefore we need to move onto 6G as soon as possible to fix the inevitable issues that the cursed 5G technology will have. Well, we are not so sure, but certainly academia and even some industry labs are already buzzing about what 6G might be. But we figure it is a safe prediction that we will see some activity in the 6G area in 2019. The big question is, will anything interesting come out of it in the next year or so? One very interesting idea that we mentioned above is auto tuning of the modulation itself. This may be a dramatic step but we predict that there will be a continuing trend towards the standard specifying less and less as we leave gaps in the specification for machine learning to set chunks of the modem operation on the fly. Maybe a new era for how standards are developed?

9. **We Are Finally Free from the Tyranny of Moore's Law**
   "What?" you say. "We are supposed to like Moore's law". But from a design perspective I would argue that it made our lives too easy and also allowed management to treat us poor old design engineers as commodity products. Well, just like it took a couple of year to work out if Voyager has really left the solar system, it has taken a few years for Moore's Law to properly die, but now it really has. We predict several communication systems related things from this event. First, operators will not be able to expect 2X performance improvement every 2 years. We will have to think harder at what improvements we really care about in the network. Second, communication equipment manufacturers will have to learn to really appreciate their smart design engineers as there is no free lunch any more. Third, communications standards will have to pay attention to implementation a lot more before specifying something that simply isn't realizable. Fourth, there will be a lot more room for exotic technologies to play a role as commodity CMOS will not smother them anymore. For instance carbon nanotubes, vertical integration, optical compute, advanced packaging, processing in memory, approximate computing, what else? Power brokers in the silicon architecture space are now predicting the rise of "domain specific architectures" and configurable architectures, and though a lot of this may be window dressing on existing technology you can feel the ground start to shift. Basically our jobs are about to get a lot more interesting and that can only be good right?

10. **Finally We Move Past the Cellphone**
    OK, this probably isn't going to happen in the next year but we would like it to. Certainly there are some signs of dramatic shifts being made, though as we said above they didn't make a splash at CES this year. This month a "holographic phone" was announced. We will let you make up your own minds about it but some operators are already promising to offer it. The addition of AI to the cell phone, which we poo pooed above, we will now add to this list as a possible disruptor of the usual functionality of the cell phone. Put just these two together and the opportunity to get out of the screen and allow some intelligent adaptation of the UI to match individual customer satisfaction will be an opportunity to redefine the fundamentals of what a cell phone really is. On top of that there are signs that Android has on the wireless appliance market is loosening due to its lack of penetration in the IoT space. In the opinion of some analysts Android enabled smart phones but perhaps is not enabling their evolution so much. Certainly handset manufacturers need to find more space to compete and differentiate and this pressure will find a way out into new types of devices. So for this year we predict the end of the cell phone and the beginning of a completely new relationship with your wireless device. Something perhaps that will bring together the other 9 trends and give the user a completely new way to appreciate all of this new technology. We can only hope.

Communication Technologies Include

- The Internet
- Multimedia
- E-mail
- Telephony
- And other sound-based and video-based communication